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Attention: Dr. T.L.K. Smull, Director

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Gentlemen:

This the 5th quarterly status report on Contract No. NASr-54(03), covering the period February 1, 1964 to April 30, 1964.

The project effort during the quarter was distributed among the following tasks.

(1) Laboratory Testing of Radiation Measuring Instruments

(2) Aircraft Flight Tests of the NIMBUS MRIR and HRIR Radiometers

(3) Analysis of Data Obtained on Previous Balloon Flights.—Data Processing Equipment

(4) Design and Construction of Equipment for Next Balloon Flight

(5) Analytical Study of Atmospheric Radiation Processes

(6) Study of Stellar Refraction as a Meteorological Satellite Technique

(7) Report Writing

(8) Development of Infra-Red Interferometer for Spacecraft Use

The interferometer development (item 8 above) has received great emphasis; by the end of April the major portion of the effort of the laboratory was devoted to this task.

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XEROX $ 1.00
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REPORTS CONTROL No. 3

1. LABORATORY TESTING OF RADIATION MEASURING INSTRUMENTS

The hemispherical cavity source for "visible" channel calibrations has been completed. Although an exhaustive set of tests to determine the characteristics of the source has not been made, its essential characteristics have been determined.

The source has been used to calibrate the visible channels of the TIROS and NIMBUS 5-channel radiometers and to calibrate the Perkin-Elmer SG-4 spectrophotometer in the 0.4 to 1.0 micron range.

The thermal channels of the NIMBUS MRIR radiometer were also re-calibrated after the aircraft flight tests. The characteristics of the instrument seem to have changed since the last set of calibrations. This change is confirmed by another set of calibrations made at NASA Goddard Space Flight Center.

2. AIRCRAFT FLIGHT TESTS OF NIMBUS MRIR AND HRIR RADIOMETERS

The program of aircraft flight tests of the NIMBUS MRIR and HRIR radiometers was completed during the month of February with a series of 8 additional flights. Three of the flights were based at Patrick AFB with measurements over Eleuthera Island, the other 5 were made from Edwards AFB with measurements over a dry lake bed which is near the base.

The following table is a list of the flights of this program.

No.	Date	Time	Location
8001	12-10-63	1712 E	Patrick (Bahama)
8002	12-12-63	2120 E	"
8003	1-10-64	1604 E	"
8004	1-13-64	1427 E	"
8005	1-17-64	1523 E	"
8006	1-20-64	1835 E	"
8007	1-22-64	2033 E	" (Eleuthera)
8008	1-23-64	1017 E	" "
8009	1-23-64	1442 E	" "
8010	1-27-64	1848 E	" "
8011	1-29-64	1830 E	" "
8012	1-30-64	1845 E	" "
8013	2- 5-64	1113 E	" "

No.	Date	Time	Location
8014	2-17-64	1413 E	Patrick (Eleuthera)
8015	2-17-64	1844 E	" "
8016	2-20-64	1727 M	Edwards AFB
8017	2-20-64	2333 M	" "
8018	2-21-64	1442 M	" "
8019	2-21-64	1830 M	" "
8020	2-21-64	2255 M	" "

3. ANALYSIS OF DATA OBTAINED ON PREVIOUS BALLOON FLIGHTS.— DATA PROCESSING EQUIPMENT

The analysis of the 26 June, 1963 balloon flight data has continued.

The TIROS radiometer channel IV data has been processed for the entire flight, using the before flight calibrations. The resulting data, however does not seem to be correct. The equivalent black body temperature readings are always low by as much as -15 to -20°C according to in-flight black body calibrations. The radiometer readings are also low by about the same amount when compared to NIMBUS MRIR readings at the same zenith angle.

The NIMBUS MRIR Channel IV data has been processed for a major portion of the balloon flight. The housing and black body calibration readings are in agreement. The data obtained with this channel of the MRIR look excellent.

The data processing equipment available for use in the laboratory has been modified for analysis of the NIMBUS MRIR data. Equipment now being used plays back flight magnetic tapes at 1/4 speed so that our A/D equipment can obtain 50 samples per second.

Other equipment available for use by personnel of our lab. is available in the Meteorology Department of The University. This equipment is somewhat more sophisticated, but requires that we move our ground station over to the East Engineering Building. Considerable set-up time is required and time available to us is limited.

The new data processing system being supplied to the Space Physics Department for joint use with our laboratory has been considered carefully by personnel of both laboratories. A complete set of specifications necessary for procurement has been agreed upon.

4. DESIGN AND CONSTRUCTION OF EQUIPMENT FOR THE NEXT BALLOON FLIGHT

Work on the equipment for the next balloon flight was well under way at the end of April. A new balloon gondola has been designed and its construction has almost been completed.

Telemetry requirements for this balloon flight have been established jointly by U.M., U.S. Weather Bureau and JPL personnel. Additional airborne and ground station telemetry equipment is needed. This equipment has been specified and ordered. The voltage controlled oscillators needed are no longer in production by the company that originally made them, however an agreement has been made with them to supply us with sufficient material so that we can build them ourselves.

The electrical timing control and power supply system for the balloon gondola have been designed and material has been ordered. A new photocell device for measuring the azimuth orientation of the balloon gondola with respect to the sun has been designed and partially constructed. A series of tests to determine the effect of low pressures (5mb) on the operation of Yardney silver cells has been begun.

Additional magnetic tape recording equipment is needed for this balloon flight. JPL personnel have agreed to supply an Ampex CP-100 portable tape recorder to meet this requirement.

Other ground station equipment was received, this included several new phase-lock discriminators and a new 5KW Onan generator. This equipment has been installed in the bus. The bus power and telemetry wiring has been completely modified. Old wiring has been removed and a new control panel, telemetry patch panel and galvanometer attenuator board has been built and installed.

5. ANALYTICAL STUDY OF ATMOSPHERIC RADIATION PROCESSES

Work has continued on programming the calculation of atmospheric transmission in the 15 micron CO_2 band, integrating directly across the band, instead of assuming an absorption band model. Results have been obtained for a vertical path. The transmissivity has been averaged over 0.1 cm^{-1} intervals for a 60 cm^{-1} wide portion of the center of the band, including the main Q branch, and is given for about 30 different pressure levels.

These data have been used to compute the vertical component of outgoing radiation from the earth and its atmosphere and applied to the "Kaplan"

experiment which is designed to deduce an atmospheric temperature structure from radiometric measurements.

The computer program will be extended to include atmospheric slant paths and to complete calculations for the entire band.

6. STUDY OF STELLAR REFRACTION AS A METEOROLOGICAL SATELLITE TECHNIQUE

During this period work continued on the error analysis. The computerization of the recovery of density as a function of height when given refraction angle as a function of height was completed. Variation of parameters was begun to determine RMS star-tracker accuracy and readout frequency requirements.

A study of the transmission of starlight through the atmosphere was begun in order to determine the shape and spectral intensities of the star image incident on the star-tracker photosurface.

7. REPORT WRITING

A technical report, "Reflectance of Kodak White Paper" by F. L. Bartman, L. W. Chaney, and M. T. Surh, Univ. of Mich. ORA Report No. 05863-5-T was completed and distributed.

8. DEVELOPMENT OF AN INFRARED INTERFEROMETER FOR SPACECRAFT USE

The initial design of an infra-red interferometer for spacecraft use was completed. The development of this instrument will be a cooperative effort with personnel of the Aeronomy and Meteorology Division, Goddard Space Flight Center, NASA. The interferometer optics will be worked on by U. of M. personnel and portions of the necessary electronics will be developed at NASA. The performance specification aimed at is a spectral range of 500 to 1700 cm^{-1} with 5 cm^{-1} resolution in the range of 500 to 1000 cm^{-1}, deteriorating to 8 cm^{-1} at 1700 cm^{-1}.

Optical layouts have been made and requests to bid for optical components have been sent to 9 companies. Both KBR and Irtran 4 optical components are being procured, in order to determine by laboratory test which is best for

this application. Initially the interferometer will be assembled with glass optics for visual test of the movable mirror drive system. Several configurations are being considered for the exit optics and detector.

The initial mechanical drive was constructed. The mirror will be supported by parallel leaf springs, with drive by a coil in a magnetic field. The magnetic field will be completely self-enclosed with the coil suspended in the center of the unit. The current through the coil will be controlled by feedback circuits which will use a sine wave produced by a separate interferometer using the 0.5852μ line of neon as a source. The reference signal will be used to control the motion of the mirror and to control sampling of the interferogram.

All of the components necessary to assemble a scientific breadboard had been ordered by the end of April.

9. SUMMARY OF FUTURE WORK

The following tasks will receive major attention during the next work period.

(a) Development of the infra-red interferometer for spacecraft use.

(b) Analyses of the data from the last balloon flight and from the aircraft flight tests.

(c) Design, construction and testing of equipment for the next balloon flight.

(d) Analytical study of atmospheric radiation processes.

(e) Report writing.